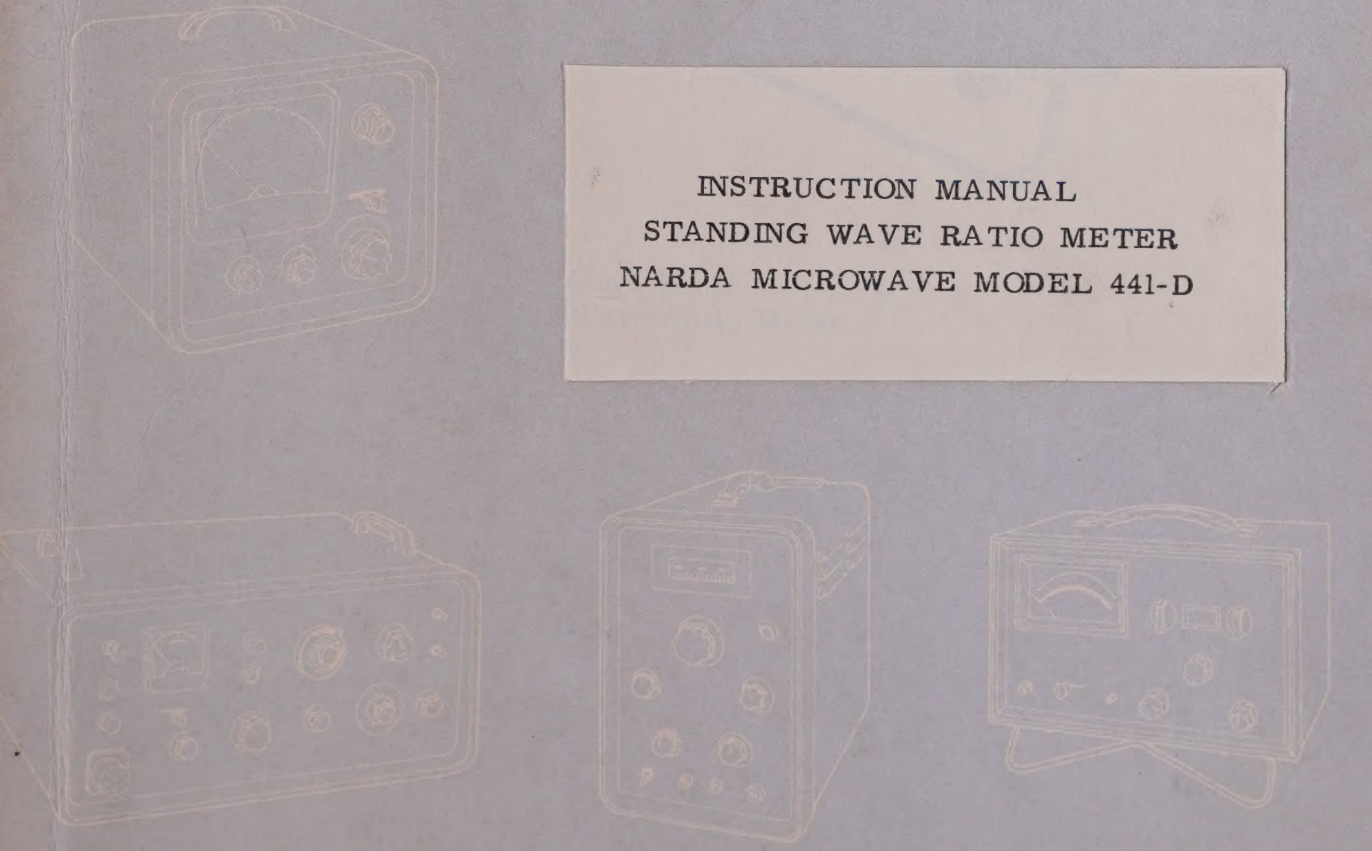
the narda microwave corporation

INSTRUCTION MANUAL
STANDING WAVE RATIO METER
NARDA MICROWAVE MODEL 441-D



microwave and uhf electronic test equipment

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STANDING WAVE RATIO METER
NARDA MICROWAVE MODEL 441-D

May 1965

The NARDA Microwave Corporation

Model 441 D
Standing Wave Ratio Meter

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SECTION I

GENERAL

The Narda Model 441D is basically a high gain tuned amplifier consisting of a regulated power supply, a low noise tuned amplifier, precision audio attenuators and a meter calibrated for use with a square law detector. For bolometer operation, the Model 441D supplies the bias current to the bolometer element to bring the resistance to the correct operating point.

FEATURES of this instrument are:

1. Digital readout of attenuation in 2db steps simplifies test measurements.
2. Front panel adjustments for 4.5 or 8.75 ma bolometers.
3. Frequency adjustable from 975 to 1025 cps.
4. Bandwidth continuously adjustable from 10 to 200 cps.
5. Meter reads state of battery charge and bolometer bias current for 4.5 and 8.75 ma bolometer.
6. Front panel switch for fast or slow meter response.
7. Detachable three conductor power cable for AC operation.

APPLICATION INFORMATION

As in any tuned amplifier as highly sensitive as the Model 441D, care must be taken when operating it in close proximity to other similar devices to prevent pick-up from extraneous radiations. This pertains only to the 50 and 60db scales at maximum gain and narrowest bandwidth.

SECTION II

SPECIFICATIONS

GAIN	Less than 0.1 microvolt at 30 cps for full scale deflection on 60 db range over complete temperature range of 0°C to 55°C.
NOISE	With gain adjusted for 0.1 uv input for full scale: (a) 7 db below full scale at 10 cps bandwidth (b) 5 db below full scale at 30 cps bandwidth
FREQUENCY (Front panel knob)	1000 cps continuously adjustable from less than 975 cps to more than 1025 cps. Stability - 0.0025%/°C. (On special order any center frequency from 300-3000 cps.)
BANDWIDTH (Front panel knob)	Continuously adjustable from 10 cps (for highest sensitivity, lowest noise) to 200 cps (for sweep frequency testing). Stability - ± 5% from 0°C to 55°C at 30 cps bandwidth.
INPUTS	Crystal, low and high current bolometers.
POWER REQUIREMENTS	115 or 230 volts AC, 50 to 500 cps 2 watts or (with optional, extra charge battery pack) completely portable DC operation free from power line disturbances and spurious grounds. Built-in recharger provides overnight recharge after 10 hours operation.
ACCURACY	Normal ± 0.1 db/10db step ± 0.2 db maximum cumulative. Normal - Expand ± 0.1 db when switching from any 10 db step (NORMAL) to any 2 db step (EXPAND), except ± 0.04 db when switching to 0.0db (EXPAND). Expand ± 0.02 db/2db step ± 0.05 db maximum cumulative. Meter Linearity ± 0.5% of full scale (Less than ± 0.02 db on EXPAND DB scale)

RANGE	2 db steps in EXPAND function 0 to 70 db in 2 db steps 10 db range on GAIN control 1 db range on FINE GAIN control
METER SCALES	VSWR NORMAL 1.0 to 4.3 to 10 VSWR EXPAND 1.0 to 1.25 MIRROR SCALE DB NORMAL 0 to 10 db DB EXPAND 0 to 2 db MIRROR SCALE 4.5 ma bolo bias, 8.75 ma bolo bias, battery voltage Meter response FAST or SLOW, front panel switch Automatic registration between scales
RECORDER OUTPUT	1 ma into 1500 ohms ± 10% at full scale deflection on all ranges Meter is still operating when recorder jack is in use
AC AMPLIFIER OUTPUT	1.0 volt RMS across 500 ohms minimum.

SECTION III

OPERATING PROCEDURE

1. POWER REQUIREMENT
The Model 441D may be operated from an AC source of 115 or 230 volts at 500 cps (power line frequency and the Model 441D tuned amplifier frequency should not be harmonically related). With the instrument disconnected from the AC power, set the LINE VOLTAGE switch (located on the rear panel) to the desired position.

2. BATTERY OPERATION
The Model 441-D may be operated from a battery instead of the 115 or 230 Volt AC supply. The rechargeable nickle-cadmium battery is factory installed if ordered as option A. (The same battery may be ordered and installed later. To obtain this, order Narda stock number 441 D-226.To install battery refer to Section V-2).

   a. INITIAL BATTERY USE: When the 441-D is to be battery operated for the first time, set the POWER SELECTOR switch to CHARGE and allow the battery to charge for a minimum of 16 hours.

   b. BATTERY ON: AC voltage to the instrument power supply is disconnected and the battery supplies all power. The pilot light is off. The Model 441-D chassis remains to the power line ground unless the power cord is removed. The battery supplies approximately 70 ma to the instrument and all circuits are DC regulated.

   c. BATTERY CHARGE: Set POWER SELECTOR switch to CHARGE. AC power is supplied to the instrument and the pilot light is on. The Model 441-D is inoperative and approximately 40 ma DC charging current is supplied to the battery. The battery cannot be damaged by prolonged overcharging.

   d. OPTIMUM BATTERY USEAGE: It is recommended that Model 441-D be operated on battery for up to 10 hours, followed by 16 hours of recharge.

   e. AC OPERATION: When the 441-D is operated on AC, the pilot light is illuminated. Approximately 715 ma DC "trickle charge" is applied to the battery.

3. VSWR MEASUREMENT

a. Place the Model 441D power switch to AC (or battery, if used).

b. Set INPUT SELECTOR for type detector being used. Connect detector cable to INPUT.

c. Bolometer bias may be checked by moving BOLO BIAS switch to extreme right.

d. Set RANGE switch to 40 db or 50 db NORM (normal) position. Adjust probe depth to obtain an on-scale reading. (It is recommended that probe depth be kept at a minimum. Deep probe depth causes errors in VSWR readings).

e. Peak Model 441D (needle moves to right) by adjusting the modulation frequency of the signal source, if adjustable. Frequency peaking is also achieved by adjusting the FREQUENCY control knob located on the front panel of the MODEL 441D.

f. Tune probe, if tuneable, to maximum output. Reduce probe depth to keep on-scale METER reading.

g. Move the probe along the line to obtain reading on the Model 441D METER.

h. Adjust GAIN of Model 441D and/or output power from the signal source to obtain a VSWR reading of exactly 1.0.

i. Move the probe along the line to obtain a voltage minimum (needle moves left).

j. If the indicated VSWR is between 1 and 1.25, greater accuracy is obtained if the Model 441D EXPD (expand) function is utilized. For a VSWR between 1 and 1.25 a VSWR scale is provided when the RANGE switch is changed to EXPD position.

k. For a reading between 1 and 3 on the 1 to 4 VSWR scale, change RANGE switch to NORM position.

1. For a VSWR reading between 3 and 10 on the 3 to 10 VSWR scale, change the RANGE switch to the next 10db position above the initial setting.

4. ATTENUATION MEASUREMENT

Because the Model 441D METER provides a high resolution DB scale, the insertion attenuation in a line may be measured (within the accuracy of the detector). This same basic procedure may be used to check the accuracy of any variable attenuator. The procedure is outlined below.

a. With the attenuation to be measured out of the circuit, select an appropriate RANGE switch (dependent upon value of attenuation to be measured) in the NORM (normal) operating position.

b. Adjust the GAIN control for "0" db reference.

c. Insert the attenuation to be measured and change the RANGE switch to obtain an on-scale reading on the 0 to 10 db scale (for example, assume the Model 441D was initially set on the 40 db scale and when the RANGE switch is changed to 50 db the Model 441D indicates a reading of approximately 3 db.

d. Observe which 2 db segment the meter needle lies within (2 to 4 db for this example) and set EXPD (expand) switch to select this segment (set to 2 db). This expands the selected segment to a full scale presentation while automatically normalizing the selected starting point of the scale (2.0) to "0" on the db scale.

e. Read the indication on the 0 to 2 db EXPAND scale (for this example assume 1.3).

f. The total inserted attenuation = (RANGE switch setting) + (EXPD switch setting) + (METER reading on the 0 to 2 db EXPAND scale) - (initial RANGE switch setting). (For this example: 50 db + 2 db + 1.3 db - 40 db = 13.3db)

SECTION IV

OPERATING CONTROLS

Figures 4-1 and 4-2 illustrate the front and rear panels respectively of the Model 441D and are indexed to a tabular listing of the controls and their function.

Index No.	Name	Description
1	10DB RANGE SWITCH	Provides 0-60db in 10db steps.
2	2DB RANGE SWITCH	This control determines either NORMAL or EXPAND operation, and provides 0-8db in 2db steps.
3	COARSE GAIN CONTROL	Provides a 10db variation of the overall gain of the 441D.
4	FINE GAIN CONTROL	Provides a 1db variation of the overall gain.
5	BANDWIDTH	Provides continuous adjustment of the bandwidth from 10 cps to 200 cps.
6	FREQUENCY	Adjustable from 975 to 1025 cps.
7	METER RESPONSE	Provides selection of slow or fast meter.
8	INPUT SELECTOR 8.75 and 4.5 BOLO	Provides current to a bolometer connected to the INPUT jack. Presents a nominal 350 ohms impedance to a crystal connected at the INPUT jack.

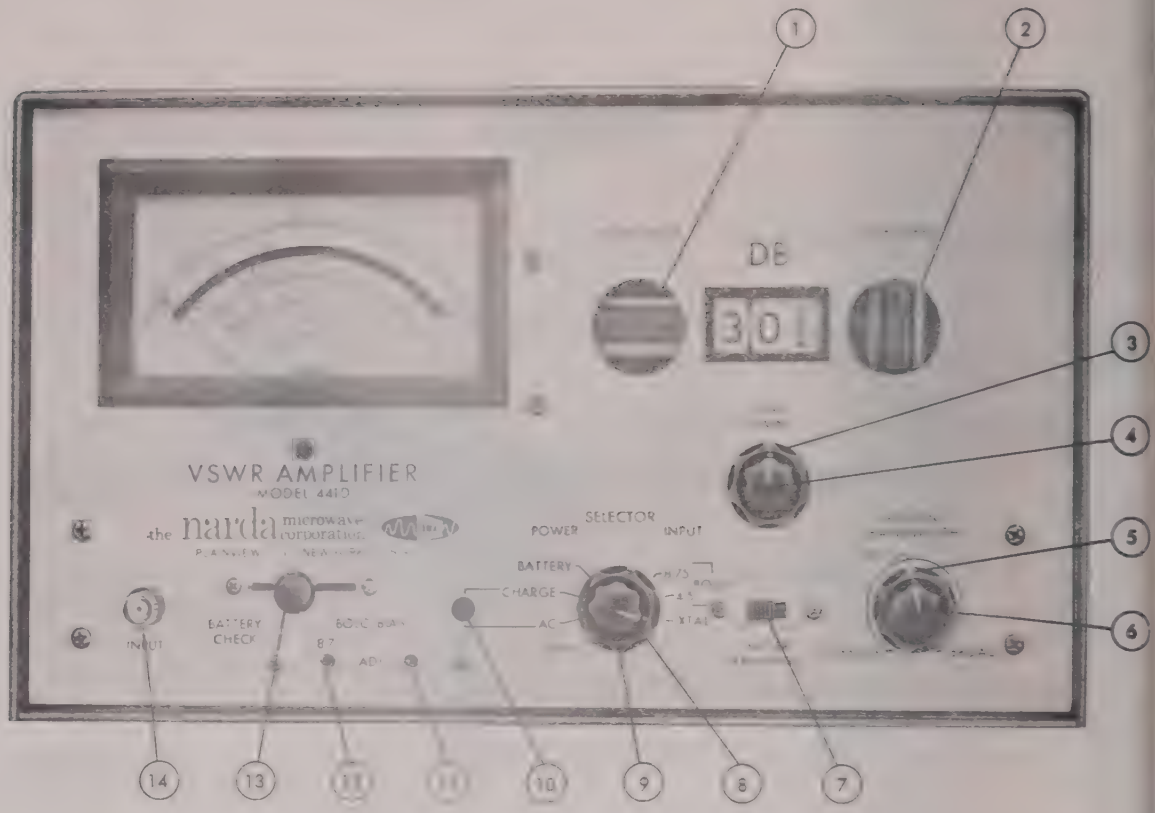


FIGURE 4-1 FRONT PANEL OPERATING CONTROLS AND CONNECTORS

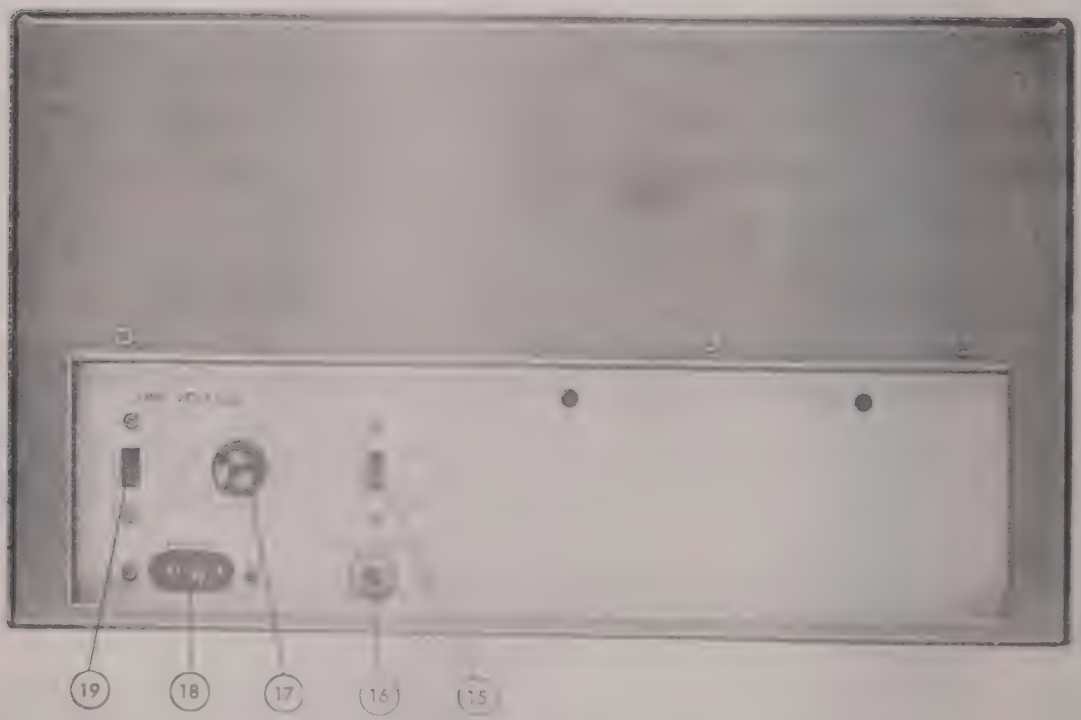


FIGURE 4-2 REAR PANEL OPERATING CONTROLS AND CONNECTOR

Index No.	Name	Description
9	**POWER SELECTOR**	Provides selection of AC or BATTERY operation or CHARGE. In the CHARGE position, the 441D is inoperative and the internal power supply charges the battery.
10	AC and CHARGE INDICATOR	Illuminates when POWER SELECTOR switch is in AC or CHARGE position.
11	4.5 ma BOLO BIAS ADJ	These controls provide independent adjustment of the 8.75 and 4.5 ma current. This charge is observed on the panel meter when the INPUT SELECTOR is in the 8.75 or 4.5 ma position respectively.
12	8.75 ma BOLO BIAS ADJ	
13	BATTERY-BOLO SWITCH Battery Position	(Momentary left) - Provices an indication on the panel meter of the relative battery voltage. The battery should be recharged when the relative battery voltage is on or below the indicated line.
	Bolo Bias Position	(Momentary right) - Indicates bolometer current directly on meter.
14	INPUT	BNC Connector for an input from the signal source.
15	AC-DC SWITCH	Provides selection of AC or DC output.
16	RECORDER OUTPUT	Supplies a DC output for recorder use, with AC-DC switch in DC position. With switch in AC position, provides use of the 441D as a tuned amplifier. (This output is affected by BANDWIDTH control)

Index No.	Name	Description
17	FUSE HOLDER	Contains 1/32 ampere line fuse.
18	POWER	Receptacle for three-conductor AC power line cord
19	LINE VOLTAGE SWITCH	Provides selection of operating the 441D from either 115 or 230 VAC line voltage.

SECTION V

THEORY OF OPERATION

Figure 5-1 illustrates a functional block diagram of the Model 41D. The unit consists of attenuator networks, an expand circuit, pre-amplifier, tuned amplifier, meter amplifier, bolometer bias supply and a regulated power supply.

1. RANGE ATTENUATOR
The attenuator network consists of range switch S-104 with attenuation networks of 120 db. S-104A and B supply 80 db in 20 db steps. S-104C and D, situated after the pre-amplifier section (Q1-Q3), supplies 40 db in 20 db steps. Expand range attenuator, S-105 A and B, supplies 16 db in 4 steps. On EXPD 0 DB position, all 4 steps (16 db) are in the circuit.

2. PRE-AMPLIFIER
Transistors Q1, Q2 and Q3 comprise the pre-amplifier stage. After the signal goes through the first attenuation stage of 80 db, it is fed into the input stage Q1, amplified and fed into the remaining 40 db attenuator stage (S-104 C and D). This technique provides low noise performance where it is needed most. High ripple rejection is obtained by employing a double R-C network in the collector circuit of Q1 and Q2. R-18 sets the gain of the amplifier by varying the gain of Q3.

3. EXPAND CIRCUIT
The expand circuit provides a full scale meter deflection for a 2 db increment, while maintaining the original reference level. This is accomplished by applying a precise back bias current to the meter (M). On expand position, the gain is increased by taking out attenuation (R121-123) and a back bias is fed to the meter (M). This back bias provides for a 2db full scale deflection.

4. TUNED AMPLIFIER
Transistors Q5 and Q6, along with R118 and C24, comprise the variable bandwidth, variable frequency, tuned amplifier. The normal operating frequency is 1000 cps; this frequency is adjustable over a ± 2.5% range by varying C24. The bandwidth adjustment, R118, varies the bandwidth of the unit from 10 to 200 cps. For normal operation, the bandwidth is 30 cps. The gain of the unit is controlled by coarse gain pot R-120 and fine gain pot R-119.

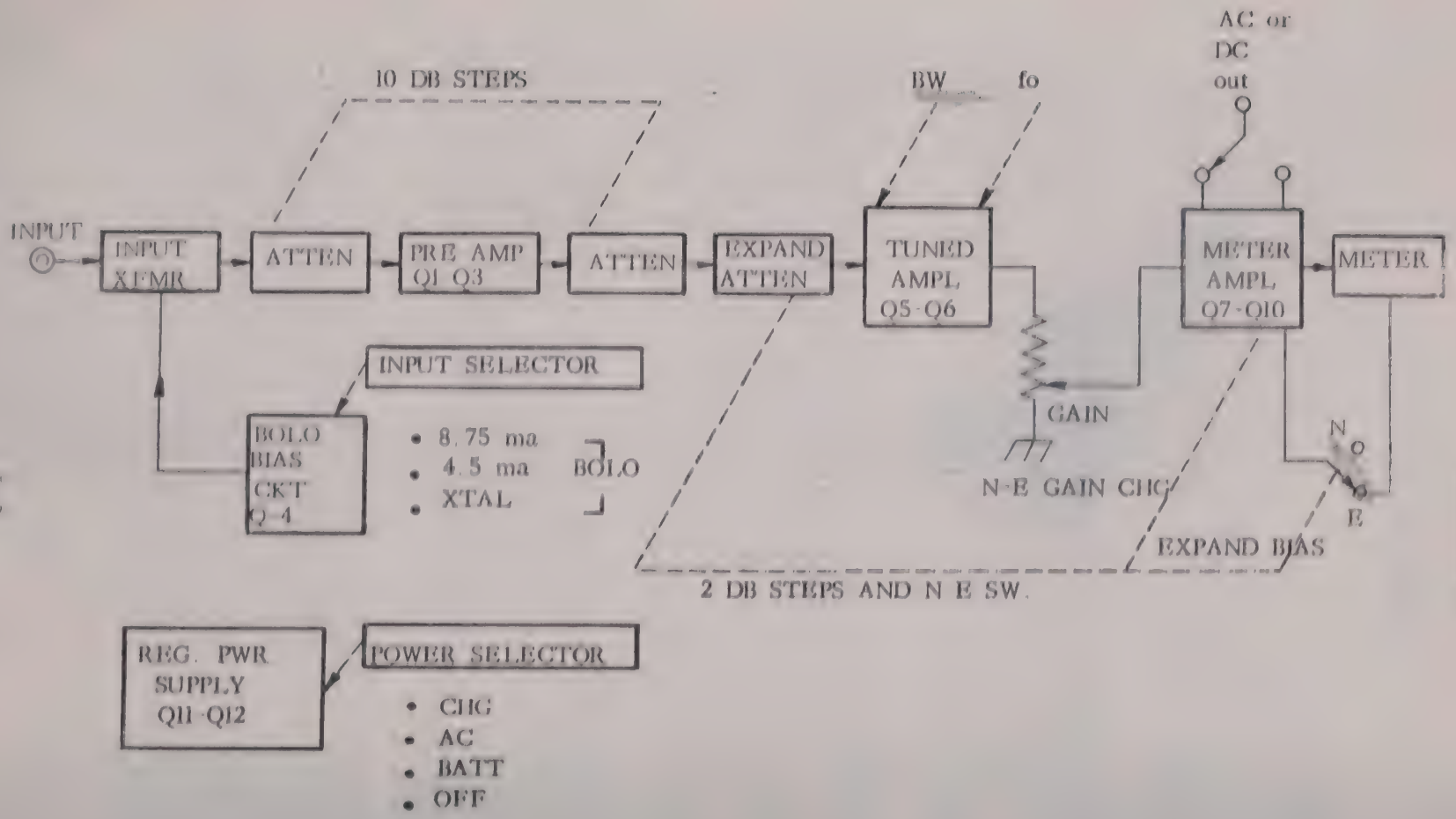


Figure 5-1 FUNCTIONAL BLOCK DIAGRAM OF MODEL 441D

5. METER AMPLIFIER

Transistors Q7 through Q10 amplify the signal. The amplified signal is then rectified by the bridge rectifier diodes, CR1 and CR2. The rectified output from the bridge is indicated by the meter (M). The meter is calibrated for use with Square Law Detectors whose voltage output varies directly with input power.

6. BOLO BIAS SUPPLY

The bolo bias supply consists of transistor Q4, S-102-B and associated resistors. Q4 determines the bias of the bolometer connected at the INPUT jack, J1. Q4 also serves as a bolometer burnout protection device, by limiting the voltage supplied to J1. Bolometer bias may be checked by setting S-102-B to Bolometer Check Position. The meter is calibrated to read bias current for 4.5 and 8.75 bolometers. The bias current may be accurately adjusted by varying R-83 for the 4.5 ma bolometer and R86 for the 8.75 ma bolometer.

7. POWER SUPPLY

The power supply consists of the full wave rectifiers CR3 through CR6, control transistor Q11, and pass transistor Q12. With the INPUT SELECTOR switch on AC position, -18 volts DC is applied to the regulating circuit, Q11 and Q12. The regulated -12 volts DC can be measured on printed circuit board at the point marked -12V reg.

SECTION VI

MAINTENANCE AND CALIBRATION

1. REMOVAL OF CHASSIS

The chassis is held by four screws which are located on the rear panel. Simply remove these screws and slide the chassis out of the cabinet. Note: If unit is supplied with a battery, the battery access plate must be removed and the battery disconnected.

2. BATTERY PACK INSTALLATION

To install battery, remove unit from housing. The rear panel is supplied with two bolts to secure battery. The battery is supplied with two leads. (Red is positive and White is negative). Solder these leads to corresponding colors on terminal strip located on left side panel. Perform power supply adjustments of Section VI after battery installation.
CAUTION: IF BATTERY POLARITIES ARE REVERSED THE UNIT WILL BE DAMAGED.

3. REQUIRED EQUIPMENT ACCURACY

Calibration of this instrument, within the specifications, is not possible unless the accuracy of the test equipment is known. To check the tracking of both the RANGE and EXPAND attenuators, the attenuators used to perform these measurements must be calibrated and an error chart used.

Calibration must be known to an accuracy of ± 0.02 db for ldb steps, to ± 0.03 db for first 10 db step, and to ± 0.07 db for succeeding 10 db steps (to a total of 60 db) for attenuator.

NOTE: The Model 441D is calibrated for use with Square Law Detectors such as bolometers and crystals. The output voltage of such detectors varies directly with input power. In any of the procedures and checks where the input is controlled by an external attenuator calibrated in decibals, the Model 441D Meter will indicate 1 db change for each 2 db inserted in the input.

A 10 db change in the Model 441D Range switch corresponds to a 20db change in the input source attenuator.

4 CALIBRATION PROCEDURE

a. Power Supply Adjustments

1 Set up equipment as illustrated in Figure 6-1

2 Set 10 db range switch to NORM position· 0 DB SCALE.

3. Connect 441D through a variac, to the AC line and set the variac to 115 V AC

4. Set POWER SELECTOR to AC position

5. Connect a H.P. 412-A or equivalent to - 12V REG. and to P.S. GROUND (located on P. C. B.)

6 Connect Ballantine 320 AC VTVM or equivalent to - 12V REG and P.S. GROUND (for ripple check).

7. Adjust R-69 (on P.C.B.) for -12 volts.

8 Alternately set variac to 105V AC and 125V AC and adjust line regulation to pot R-59 until the ripple at 105V AC equals the ripple at 125V AC Reset variac to 115V AC.

9. Recheck - 12 volts, re-adjust if necessary.

b Frequency Control Adjust

1 Set up equipment as illustrated in Fig. 6-2 in calibrate position.

2 Set audio oscillator output for 1027 cps

3. Set 441D RANGE scale at any convenient position.

4 With frequency control fully ccw, adjust C44 (accessible through housing on left side of the unit) for maximum indication on METER.

c Bandwidth Adjust

1 Set up equipment as illustrated in Fig. 6-3.

2 Set audio oscillator to 1 KC

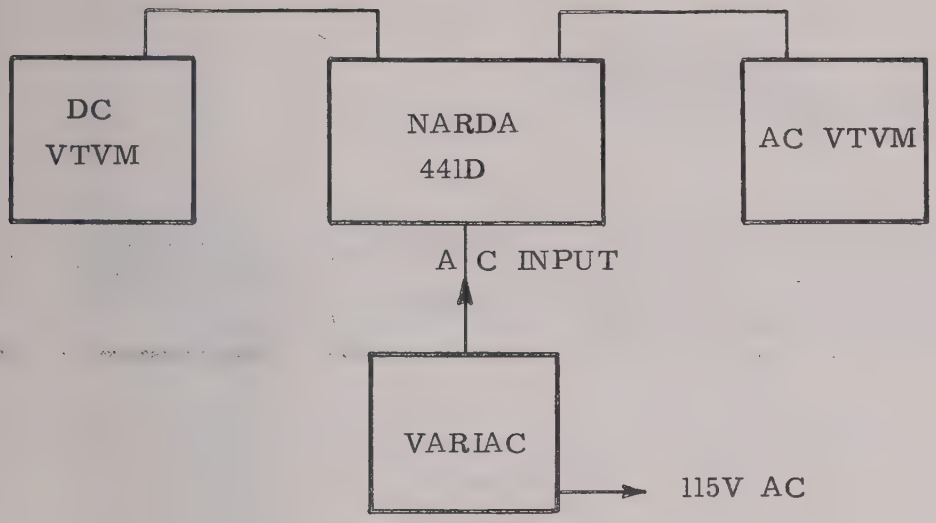
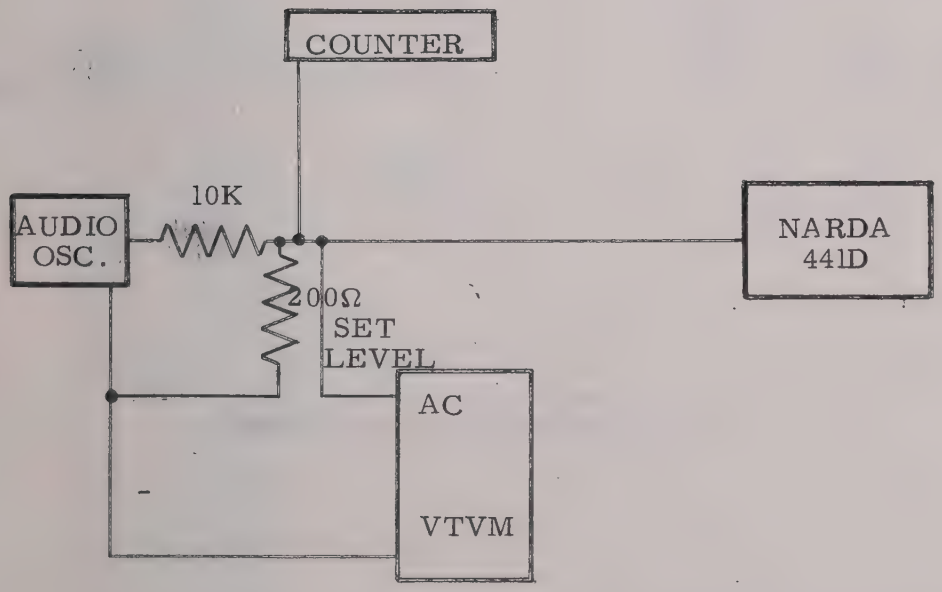


FIG. 6-1



ALL RESISTORS 1W 5%

FIG. 6-2

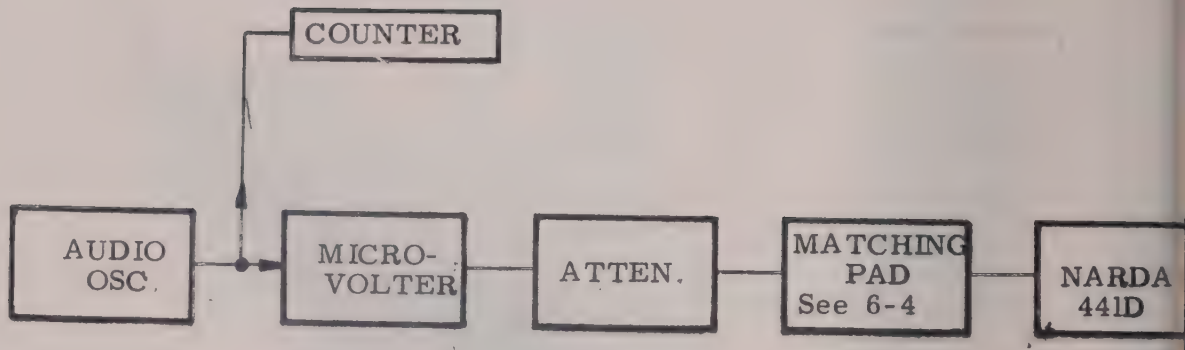


FIG. 6-3

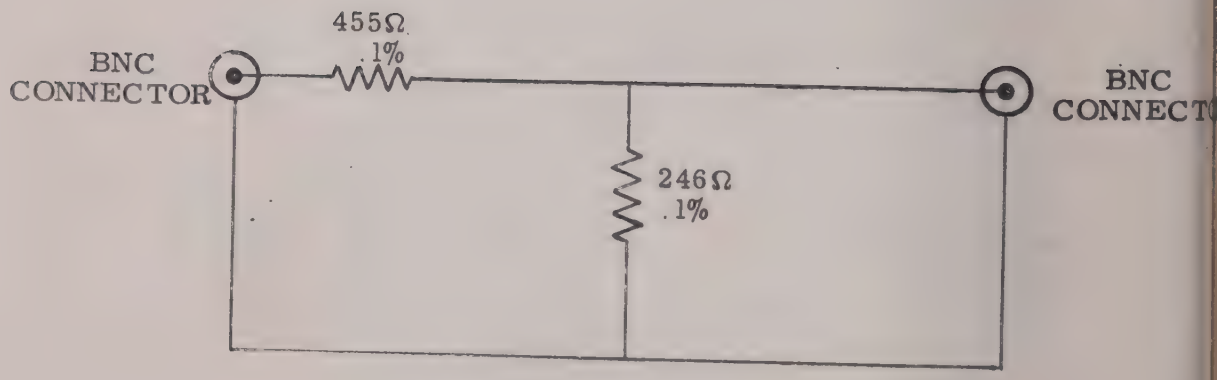


FIG. 6-4 IMPEDANCE MATCHING PAD

3. Peak 441D to 1 KC by varying FREQUENCY control. Set BANDWIDTH control to 30 cps pointer.

4. Adjust Model 441D GAIN controls to obtain a METER reading of 0 db at any convenient RANGE attenuator setting.

5. Vary audio oscillator in one direction until METER reads 1.5 db down from reference.

6. Vary audio oscillator in other direction until METER reads 1.5 db down from reference.

7. Difference between above two steps should be 30 cps

8. To reset BANDWIDTH control to 30 cps, vary BANDWIDTH control and repeat steps 5 and 6 above until difference is 30 cps. With BANDWIDTH at 30 cps loosen BANDWIDTH control knob, and set knob to correspond to 30 cps marker on front panel. Then tighten knob SET SCREW.

d. Gain Adjustment

1. Set up equipment as illustrated in Fig. 6-2.

2. Set 10 db RANGE switch to NORM position: 0db scale.

3. Set COARSE and FINE GAIN control fully CW.

4. Set audio oscillator to 1 KC, with switch in set level position, adjust audio oscillator output for 0.1 volts (full scale on AC VTVM)

5. Adjust R-18 for full scale reading

6. Check COARSE GAIN control for 10 db range minimum.

7. Check FINE GAIN control for 1 db range min. (with coarse gain control set for max. gain)

e. Expand Linearity Check

1. Set up equipment as illustrated in Fig. 6-3.
2. Set audio oscillator to 1 KC and adjust output for reading of 0 db on 546-C meter.
3. Set 1450 TBR for a minimum attenuation of 10 db.
4. Set COARSE and FINE GAIN controls to minimum.
5. Set BANDWIDTH control to 30 cps.
6. Set 10 db RANGE switch to 30, EXPD position.
7. Adjust audio oscillator output voltage for 0 db reading on Model 441D METER.
8. Set 1450 TBR to read 14 db.
9. METER should read 2 db. Re-adjust R-74 (located on P.C.B.), 2 db expand adj. pot for a METER reading of 2 db, if necessary.
10. Reset 1450 to 10 db. Use FINE GAIN control to reset METER to 0.
11. Repeat steps 8 through 10 until EXPD scale is adjusted perfectly.

f. Meter Accuracy Check

With 1450 TBR set at points tabulated, METER should read the following:

Decade Attenuator		Meter
1.0 db	=	.5 db
2.0 db	=	1.0 db
3.0 db	=	1.5 db
4.0 db	=	2.0 db

g. Normal Expand Registration Adjustment

1. Set up equipment as illustrated in Figure 6-3.
2. Set 10 db RANGE switch to 30 db NORM position.

3. Adjust signal for 0 db METER reading.

4. Set 2 db RANGE switch to 0 db EXPD.

5. Adjust R-73 for 0 DB reading on EXPAND scale.

6. Repeat steps 3 through 5 until the meter reads 0 DB on NORMAL scale and 0 DB on EXPAND scale.

7. Repeat steps f-11 and h-6 as required.

h. 10db Range Tracking

1. Set up equipment as illustrated in Figure 6-3.

2. Set audio oscillator frequency to 1KC, adjust output for reading of 0 db on 546-C meter.

3. Set 1450 TBR for a minimum attenuation of 10 db.

4. Set 441D RANGE attenuator to 0 db EXPD position, BANDWIDTH to 30 cps, GAIN controls in maximum CW position.

5. Set 546-C multiplier switch to 100 db position and adjust output control for a reading of 1 db on the 441D METER, on the 0 to 2 db EXPAND scale.

6. Switch 546-C microvolter by 20 db and the MODEL 441D RANGE switch to 10 db. Record reading of the MODEL 441D on the 0 to 2 db EXPAND scale.

7. Continue switching the 546-C microvolter in 20 db increments and increasing the 441D RANGE switch in steps of 10 db until the 546-C microvolter reads 0 db and the 441D RANGE switch reads 50 db.

8. Adjust 1450 TBR Decade Attenuator to read 30 db and increase the 441D RANGE switch to read 60 db.

9. Subtract each MODEL 441D METER reading from the previous reading. This tracking error should be within the specifications of ± 0.1 db for any 10 db step and ± 0.2 db maximum cumulative.

i. 2 DB Expd Tracking

1. Repeat steps (1) through (3) of paragraph (h).

2. Set 441D RANGE attenuator to 30 db EXPD position. Set BANDWIDTH control to 30 cps, GAIN controls to maximum CCW position.

3. Adjust 546-C microvolter to obtain a reading of 1 db on the 441D METER, on the 0 to 2 db EXPAND scale.

4. Increase the attenuation of the 1450 TBR by 4 db and the MODEL 441D EXPD RANGE switch to 2 db. Record reading of the MODEL 441D on the 0 to 2 db EXPAND scale.

5. Continue increasing the attenuation of the 1450 TBR in steps of 4 db and the MODEL 441D in steps of 2 db until the MODEL 441D EXPD RANGE attenuator reads 8 DB.

6. Subtract each MODEL 441D METER reading from the previous reading. This tracking error should be within the specifications of ± 0.02 db for any 2 db step and ± 0.05 db maximum cumulative.

5. TROUBLESHOOTING AIDS

Typical AC voltages, referenced to ground, on 0 DB NORMAL scale with a 30 cps bandwidth and full gain.

Point	RMS Voltage
Collector of Q7	16 millivolts
Junction of Q7 Collector and Q8 Base	3 millivolts
Q8 Collector	45 millivolts
Q10 Collector	1.7 volts
AC Amplifier Jack	45 millivolts

6. TEST EQUIPMENT REQUIRED FOR CALIBRATION

Variable AC Voltage Source (Variac)

H-P 412a DC VTVM or Equivalent

Ballantine 320 AC VTVM or Equivalent

H-P 200 cd or Equivalent

H-P 5512a Frequency Counter or Equivalent

GR-546-C Microvolter or Equivalent

GR-1450 TBR Decade Attenuator or Equivalent

Impedance Matching Pad (Figure 6-4)

SECTION VII

DDITIONAL EQUIPMENT

The NARDA Microwave Corporation manufactures a line of complementary equipment to be used with the MODEL 441D. Refer to ARDA Catalog or your local NARDA Sales Representatives for complete information on the following microwave items:

A. Bolometers
Used with a MODEL 441D for square law detection, for VSWR and attenuation measurements. NARDA Bolometers recommended for use with MODEL 441D.

For VSWR	N610-B
For Attenuation	N605, N610-B, N821-B, N603 (coaxial)

B. R.F. Probe
Broadband probe covers microwave frequency range. The depth is variable.

C. Slotted Line Sections
Waveguide and Coaxial Impedance Meters are available for VSWR and impedance measurements from 1.12 to 90.0Gc.

D. Detector Mounts
A complete line of Waveguide and Coaxial Bolometer Mounts are available for attenuation measurements with the MODEL 441D.

SECTION VIII

SHIPPING INSTRUCTIONS

Extra care must be taken to be certain that the unit is properly packed. Units shipped back for repair must be protected from transportation damage. If a unit arrives damaged, delay will be caused in determining who is liable. Whenever possible, the original shipping carton should be used; otherwise please follow shipping instructions carefully to assure safe arrival of the instrument.

1. Wrap the instrument in heavy kraft paper or an equivalent material.

2. Pack in a rigid container which is at least four inches larger than the unit.

3. Surround the unit with packed excelsior or similar shock absorbing material. Be certain that the packing is tight all around the unit.

4. Clearly mark the container for proper handling.

5. Insure adequately.

The following information should also be returned with the unit.

FROM: NAME _____ DATE _____
COMPANY _____
ADDRESS _____

Person to contact for further information

NAME _____
TITLE _____
COMPANY _____
ADDRESS _____

COMPLAINT: (Please describe nature of trouble)

_____

_____

_____

_____

SECTION IX

PARTS LIST

Symbol	Description (NARDA Part No.)
A	Not assigned
BT-1	Optional Nickel Cadmium Battery 441D-226
C1, C9, C34, C35, C41	Capacitor 100 uf 15WVDC Sprague 89D-217
C3, C6, C10, C13, C18, C25, C29, C30, C33	Capacitor 4 uf 15WVDC Sprague 89D-155
C2, C4, C7, C8, C12, C14, C19, C20, C21, C22, C26, C27, C28, C31, C32, C36, Thru C40	Capacitor 50 uf 15WVDC Sprague 89D-164
C5	Capacitor 200 uf 15WVDC Sprague 89D-219
C11	Capacitor 0.1 uf 200 WVDC Sprague "Pacer" Filmite "E" 192P-104-02
C15, C16, C17	Capacitor 0.1 uf 50WVDC Centralab CK-104
C23	Capacitor 2500 pf ± 2% 500 WVDC (Crimpleads) Arco DM-19-252G
C24	Capacitor No. PC 4612 Arco Electronics
C42	Capacitor 500 uf 25WVDC Cornell Dublilier BR-500-25
C43	Capacitor - Electrolytic 500 uf 50WVDC Sprague "Atams" TVA 1315
CR1, CR2	Diode, Germanium IN34A (Sub-Miniature) Glass General Instrument
CR3	Diode, Zener IN754A ± 5% Motorola, Texas Inst. or Int. Rect. Corp. only

Symbol	Description (NARDA Part No.)
DS-1	Glow Dot Pilot Light (117 ac) No. 2110A1 Industrial Devices Edgewater, N.J.
F1	Fuse - 3AG 1/32 AMP SLOW BLOW
J1	Connector - BNC per UG 1094/U (MS 35179)
J3	Jack - Switchcraft Part No. 13B
L1	Inductor 441C-313
L2	Inductor 441C - 312
M1	Meter 441C - 101
441C-317	Board Mounting Variable Resistor
441C - 330	Potentiometer and Capacitor Assembly
P1	Line Cord Belden Part No. KH4547
P2	Receptacle - Male Tower Mfg. Corp. Part No. H-1061 1G
Q1 thru Q11	Transistor 2N508A GE
Q12	Transistor 2N1184
R1	Resistor, 6100 ohms, 1/8W ± 1/2% Dale Type DCF
R2, R13, R17	Resistor 22K, 1/2W ± 5% Allen Bradley EB2235
R3	Resistor, 34.4K, 1/8W ± 1/2% Dale Type DCF
R4, R32, R50, R66	Resistor 1000 ohms, 1/2W ± 5% Allen Bradley EB1025
R5, R20, R31, R41, R67	Resistor 470 ohms, 1/2W, ± 5% Allen Bradley EB4715

Symbol	Description (NARDA Part No.)
R6	Resistor, 18.7 ohms, 1/2W, ± 1% Dale Type DCF
R7, R29	Resistor, 150 ohms, 1/2W, ± 5% Allen Bradley EB1515
R8, R35	Resistor 5100 ohms, 1/2W, ± 5% Allen Bradley EB5125
R9	Resistor, 10K ohms, 1/2W, ± 5% Allen Bradley EB1035
R10	Resistor, 330 ohms, 1/2W, ± 5% Allen Bradley EB3315
R11	Resistor, 6800 ohms, 1/2W, ± 5% Allen Bradley EB6825
R12, R18	Resistor, Variable Wire Wound IRC No. 110-100
R14, R76	Resistor, 5.6K ohms, 1/2W, ± 5% Allen Bradley EB5625
R15, R48, R60	Resistor 100 ohms, 1/2W, ± 5% Allen Bradley EB1015
R16, R63	Resistor 1200 ohms, 1/2W, ± 5% Allen Bradley EB1225
R19	Resistor 910 ohms, 1/2W, ± 5% Allen Bradley EB9115
R21	Resistor, 3900 ohms, 1/2W, ± 5% Allen Bradley EB3925
R22	Resistor, 680 ohms, 1/2W, ± 5% Allen Bradley EB6815
R23, R62	Resistor, 100K ohms, 1/2W, ± 5% Allen Bradley EB1045
R24	Resistor, 39K ohms, 1/2W, ± 5% Allen Bradley EB3935

Symbol	Description (NARDA Part No.)
R25	Resistor, 3410 ohms, 1/8W, ± 1/2% Dale Type DCF
R26, R27	Resistor, 20K ohms, 1/2W, ± 5% Allen Bradley EB2035
R28, R46	Resistor, 3000 ohms, 1/2W ± 5% Allen Bradley EB 3025
R30	Resistor, 15K ohms, 1/8W, ± 1/2% Dale Type DCF
R33, R42, R 49	Resistor, 200 ohms, 1/2W, ± 5% Allen Bradley EB2015
R34	Resistor, 180 ohms, 1/2W, ± 5% Allen Bradley EB1315
R36	Resistor, 13K ohms, 1/2W, ± 5% Allen Bradley EB1335
R37	Resistor, 51K ohms, 1/2W, ± 5% Allen Bradley EB5135
R38	Resistor, 11K ohms, 1/8W, ± 1/2% Dale Type DCF
R39, R54, R56	Resistor, 2000 ohms, 1/2W, ± 5% Allen Bradley EB2025
R40, R45	Resistor, 5600 ohms, 1/2W ± 5% Allen Bradley EB5625
R43, R44	Resistor, 82 ohms, 1/2W, ± 5% Allen Bradley EB8205
R47	Resistor, 2400 ohms, 1/2W, ± 5% Allen Bradley EB2425
R51	Resistor, 9100 ohms, 1/2W ± 5% Allen Bradley EB9125
R52	Resistor, 1800 ohms, 1/2W ± 5% Allen Bradley EB1825

Symbol	Description (NARDA Part No.)
R53	Resistor, 4700 ohms, 1/2W, ± 5% Allen Bradley EB4725
R55	Resistor, 8200 ohms, 1/2W ± 5% Allen Bradley EB8225
R57, R58	Resistor, 47 ohms, 1/2W, ± 5% Allen Bradley EB4075
R59, R69	Resistor, Variable Wire Wound, IRC No. 110-1000
R61	Resistor, 1500 ohms, 1/2W, ± 5% Allen Bradley EB1525
R64, R65	Resistor, 2500 ohms, 1W, ± 3% Dale Type RS-1A
R68	Resistor, 6630 ohms, 1/8W, ± 1% Dale Type DCF
R70	Resistor, 10 ohms, 1/2W, ± 5% Allen Bradley EB1005
R71	Resistor, 13 ohms, 1/2W, ± 5% Allen Bradley EB1305
R72	Resistor, 51 ohms, 1/2W, ± 5% Allen Bradley EB5105
R73	Resistor, Variable Wire Wound IRC No. 110-300
R74, R83, R86	Resistor, Variable Wire Wound IRC No. 110-600
R75, R80	Resistor, 23.1K ohms, 1/8W, ± 1/2% Dale Type DCF
R78	Resistor, 390 ohms, 1W, ± 5% Allen Bradley GB3915
R79	Resistor, 2.2K ohms, 1/2W, ± 5% Allen Bradley EB2235

Symbol	Description (NARDA Part No.)
R81, R85	Resistor, 360 ohms, 1/2W, ± 5% Allen Bradley EB3615
R82	Resistor, 270 ohms, 1/2W, ± 5% Allen Bradley EB2715
R84, R124	Resistor, 820 ohms, 1/2W, ± 5% Allen Bradley EB8215
R87	Resistor, 750 ohms, 1/2W, ± 5% Allen Bradley EB7515
R88 through R95	Resistor, 4090 ohms, 1/8W, ± 1/2% Dale Type DCF
R96 through R99	Resistor, 1010 ohms, 1/8W, ± 1/2% Dale Type DCF
R100 through R103	Resistor, 1640 ohms, 1/8W, ± 1/2% Dale Type DCF
R104, R105	Resistor, 404 ohms, 1/8W, ± 1/2% Dale Type DCF
R106 through R113	Resistor, 452 ohms, 1/8W, ± 1/2% Dale Type DCF
R114 through R117	Resistor, 4190 ohms, 1/8W, ± 1/2% Dale Type DCF
R119, R120	Dual Concentric Potentiometer 441C-316
R121, R122	Resistor, 1560 ohms, 1/8W, ± 1/2% Dale Type DCF
R123	Resistor 2100 ohms, 1/8W, ± 1/2% Dale Type DCF
S101	Slide Switch No. 4633
S102	Switch 441C-211
S103	Switch Lever 441C-212
S104	Switch 441C-210

Symbol	Description (NARDA Part No.)
S105	Switch 441C-209
S106	Slide Switch 441C-310
S107	Switch Assembly 441D-416
T1	Input Transformer Assembly 441D-227
T2	Power Transformer Assembly 441C-311

NOTES:

1. ALL FRONT PANEL FUNCTIONS ARE ENCLOSED BY [ ]
2. ALL CHASSIS FUNCTIONS ARE ENCLOSED BY [_]
3. ALL DC VOLTAGE READINGS ARE NOMINAL AS READ WITH A VTVM WITH RESPECT TO CHASSIS GROUND.
4. ALL RESISTANCE VALUES IN OHMS.
5. ALL CAPACITANCE VALUES IN MICROFARADS (μf) UNLESS OTHERWISE STATED.
6. ALL ROTARY SWITCHES SHOWN AS VIEWED FROM THE REAR OF SWITCH.
7. COMMON FLOATING GROUND.
8. CHASSIS GROUND.
9. THE FOLLOWING TERMINALS ARE GROUND POTENTIAL: 2, 7, 11, 13, 23, 25, 26, 27
10. DC VOLTAGES SHOWN AS X.XXV / X.XXV INDICATE A RANGE OF VOLTAGES.
11. ALL LEVER SWITCHES SHOWN AS VIEWED FROM THE CONTACT SIDE OF THE ROTOR

441D-113
SHEET 1 OF 2
B

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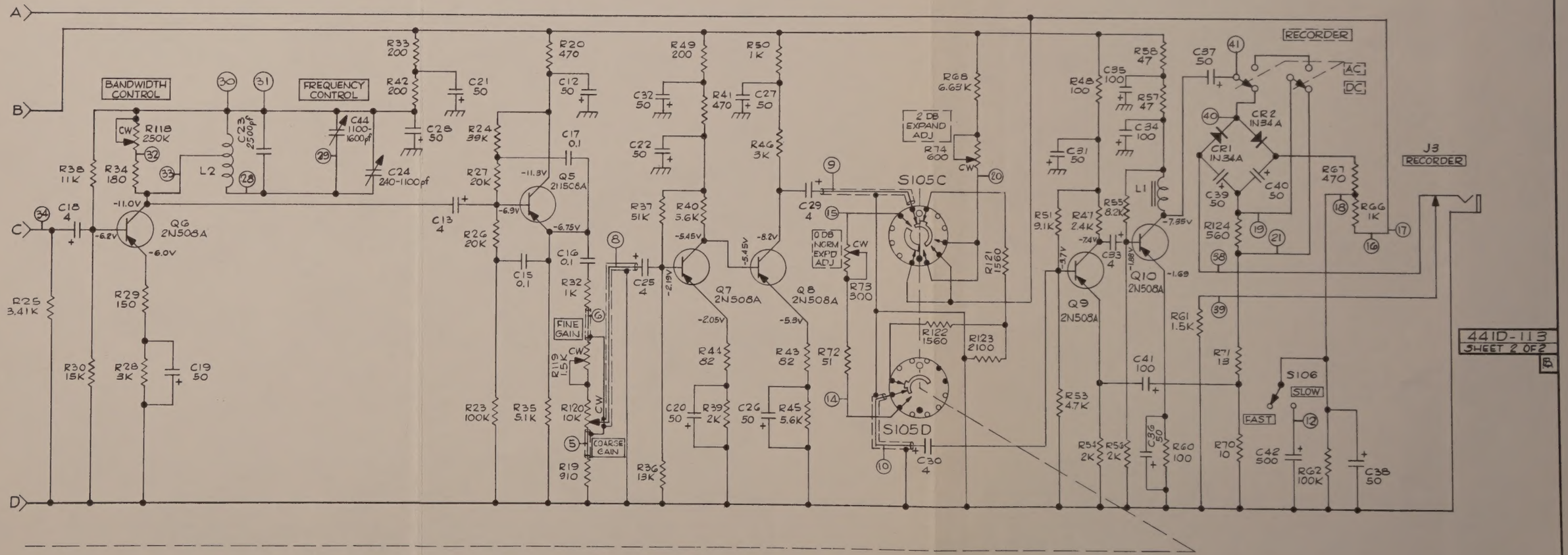

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